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INTERNATIONAL APPLICATION PUBLISHED PURSUANT TO THE PATENT COOPERATION TREATY (PCT)

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B28D 1/12, B23D 59/02 B24D 5/12		(43) International publication date: 6 February 1992 (06.02.92)

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HAUSBERGER, Peter [AT/AT]; A-6240 Radfeld 150 (AT); KERBER, Benno [AT/AT]; Anton öfner-Strasse 29, A-6130 Schwaz (AT).

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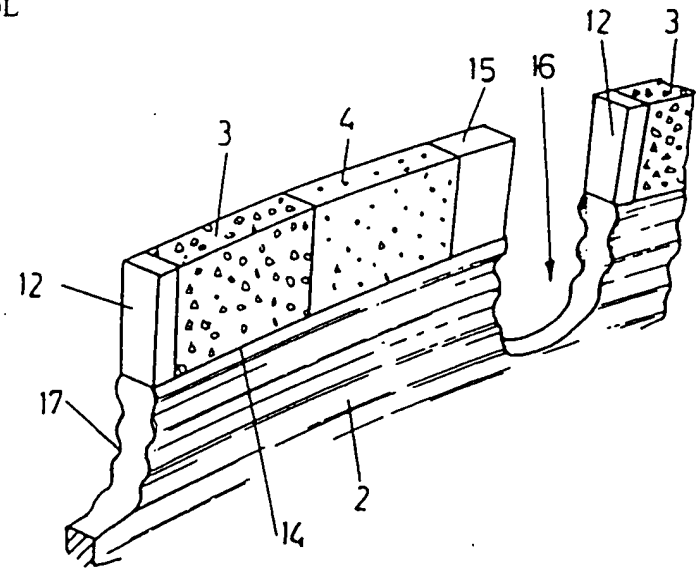
(81) Designated nations: AT (European patent), AU, BE (European patent), CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent), US.

Published
Without an international search report; to be published again after receipt of this report.

(54) Title: CUTTING TOOL



(57) Abstract [Original English]:

The invention concerns a cutting tool, e.g. a saw or hollow borer for cutting stone, with a metal support element (2) and, fixed at intervals on the support element, cutter segments (1) with preferably metal join and diamond abrasive grain. The cutter segments (1) are heterogenous in the direction of rotation. For instance, the abrasive-grain quality and/or concentration can vary over the length of the cutter segment (1) and/or the abrasive-grain size can differ. The leading edge of the cutter segment (1) has a shock-absorbing layer (12).

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DK Denmark	MG Madagascar	

+ It is not yet kn wn which states f the former Soviet Union will be covered by the term "Soviet Union."

Cutting Tool

The invention relates to a cutting tool, for example a saw, especially one for cutting stone, with a metallic support element and a grind facing made up of cutter segments fixed at intervals on the support element, with a preferably metallic join and an abrasive grain, for example diamond, wherein the grain concentration and/or the grain size and/or the grain type and/or the bonding hardness can differ over the extent of the grind facing.

The invention can be used in particular for circular saws, but it is not limited to this area of application. The cutter segments based on the invention can be used just as well for hollow borers, for example.

The cutting tool based on the invention is optimally suited to the stresses that arise in the cutting of stone.

The invention is based on the realization that in a cutting tool of the initially mentioned type, each cutter segment has periodically repeating functional divisions, namely a forward cutting zone and a rear material-removal zone.

The cutting zone has the job of loosening stone particles (for example mineral constituents) from the rock formation and of chipping material away from the interior of the cut that has been created. In the cutting zone, it is above all the abrasive grain that is subject to substantial loads.

When the forces acting to continually blunt the grain become too large, it breaks loose and leaves behind a void. The loss of this abrasive grain causes the join to be exposed to greater erosion and to undergo secondary wear, until a new abrasive grain is able to take on the job of protecting the join.

On the other hand, the material-removal zone of the cutter segment has the task of carrying away the chipped-off stone particles from the stone cut. In this process these particles are further reduced in size to some extent. In this region the abrasive grain is no longer subject to very substantial loads. Here, it is above all the join that is eroded by the abrasive stone dust. When the join is eroded so much that the abrasive grain cannot be adequately held in place, the abrasive grain breaks loose. Thus in the material-removal zone, join wear occurs primarily and grain wear occurs secondarily.

The object of the invention is to improve on a cutting tool of the initially mentioned type in such a way that above all the costly abrasive grains, generally diamonds, can be utilized better and thus the performance and/or lifetime of the cutting tool can be increased.

The object based on the invention is achieved by constructing individual cutter segments or all the cutter segments in a heterogeneous fashion with respect to the direction of rotation.

The cutter segments can be attached to the support element in the standard way, either by soldering or welding.

One advantageous provision made is to vary the quality and/or concentration of the abrasive

grain in the cutter segments over the length of the cutter segment.

One exemplary embodiment of the invention provides that the cutting-grain size should vary over the length of the cutter segments. Another provision based on the invention is for the abrasive-grain size to be largest in the forward region of the cutter segments and to decrease over the length of the cutter segments.

The concepts of front and rear relate to the direction of rotation of the cutting tool.

It is advantageous for the abrasive-grain concentration to be highest in the forward region of the cutter segments and to decrease over the length of the cutter segments.

Another exemplary embodiment of the invention provides for the join in the forward region of the cutter segments to be more elastic than that in the rear region.

Another exemplary embodiment based on the invention includes the provision that several, preferably two, different cutter-segment components, each having a homogeneous structure in itself, are fixed directly one behind the other on the support element, with these then comprising one cutter segment.

Between the cutter segment components, namely between the cutting zone and the material-removal zone, there must not be any spacing, since otherwise the cutter-segment component comprising the removal zone would again be stressed just like a cutter-segment component comprising the cutting zone.

In what follows, the invention will be described with the help of the figures in the attached drawings.

Figures 1 to 5 each show in side view a section of a circular saw, and Figure 6 depicts a cutter segment based on the invention and a portion of the support element. As shown in Figure 1, the cutter segment 1 based on the invention consists of a forward cutting zone and a rear material-removal zone directly adjoining the cutting zone, wherein the cutting zone and the removal zone differ from one another because of different abrasive-grain content and/or different bonding properties.

The support element of the cutting tool bears the reference number 2.

The requisite properties of the cutting zone 1 can be achieved by means of the following features or from a combination of the following features:

High abrasive-grain (diamond) concentration

Coarse grain size

Good diamond grades

Elastic, shock-absorbing join (sandwich construction; this leads to an enhanced edge protection)

The requisite properties of the material-removal segments 4 can be achieved by means of the following features or from a combination of the following features:

Diamond grades that have a lower strength index

At least a partial replacement of diamond by other abrasive grain, for example cubic boron nitride

Smaller grain sizes

A join with a greater resistance to abrasiveness

One of the ways that the invention can be implemented is shown in Figure 1. Here a cutter-segment component 3 is fixed on the support element 2 directly in front of a removal-segment component 4. Each cutter-segment component 3, which forms the cutting zone, and cutter-segment component 4, which forms the material-removal zone, can have a completely different structure from the other cutter-segment component. As already mentioned, the function of protecting the join in the material-removal zone (cutter-segment component 4) can also be performed by various mechanically resistant materials, conventional cutting materials, or mixtures of such materials with diamond.

The more open is the structure of the join in the material-removal zone (cutter-segment component 4), the more optimally can the chipped-away stone particles be removed with the aid of a coolant. In the case of metal-bonded systems, such an open structure for the material-removal zone (cutter-segment component 4) can be achieved by using soft admixtures, for example by adding graphite. Also a bonding system can be provided for the material-removal zone (cutter-segment component 4) that is entirely different from that provided for the cutting zone (cutter-segment component 3), for example a ceramic join or a join made of synthetic resin.

In the exemplary embodiment as in Figure 2, the transition from the cutting zone 3 to the

material-removal zone 4 is not abrupt but continuous. The cutter segment 1 changes continuously in structure from front to back, in such a way as to provide the best possible match to the respective type of stress. This can be done, for example, by providing a continuous change in concentration of the diamond grain and/or a continuous change in the bonding properties and/or a continuous change in the mixture ratio between diamond grain and other mechanically resistant materials.

The bonding properties in the rear portion of cutter segment 1, namely in the material-removal zone, can be changed by a supplementary heat treatment or infiltration.

As Figure 3 shows, the continuous change in the stress on the cutting segment can also be provided for by having a segment structure that changes in stepwise fashion. In this case a number of segment components 5, 6, 7, 8, 9, 10 with different structures can be fixed one behind the other on the support element 2.

The changes in the structure of the segment components 5 to 10 - from the first segment component 5 with a structure that matches the cutting zone one hundred percent, to the last segment component 10 with a structure that matches the material-removal zone one hundred percent - can be achieved by the measures described above.

It is possible to force [sic] a change in the way the cutting tool functions by providing a number of cutter-segment components 3, 4 within a cutter segment 1, wherein one cutter-segment component 3, which forms a cutting zone, and one cutter-segment component 4, which forms a material-removal zone, always alternate with one other and in combination make up a double

unit 11. A number of these double units 11 can be fixed in succession on the support element 2 to form the cutter segment 1. In contrast to the exemplary embodiments just described, in this embodiment the wear on each of the forward and each of the rear halves of the double unit 11 should not be equal. As Figure 5 shows, due to the working process a peak-and-valley profile should develop. The valleys 13 that have developed lead to an improved carrying off of chipped-away stone and coolant. The various different wear properties in the cutting zone and material-removal zone of a double segment 11 can be achieved by providing the following features or a combination of the following features:

Varying the join

Varying the abrasive-grain (diamond) concentration

Varying the abrasive-grain quality

Varying the aftertreatment of the join.

In the exemplary embodiment shown in Figure 6, the grinding segment 1, like that of the embodiment of Figure 1, has a cutter-segment component 3, which forms the cutting zone, and a cutter-segment 4, which forms the material-removal zone. However, in front of cutting zone 3 a thin shock-absorbing layer 12 is provided, which is made of a nonferrous metal, for example.

The cutter-segment component 3 also has absorbing properties, which are achieved by providing a relatively soft join and possibly also a sandwich structure for the cutter-segment component 3.

Furthermore the cutter-segment component 3, which forms the cutting zone 3, is not fixed

directly to the support element 2, but instead is attached by means of a likewise absorbing solder layer 14.

Again the cutter-segment component 4 of the material-removal zone has a lower abrasive-grain concentration, with the diamond grain having been replaced to some extent by various mechanically resistant materials. The join is harder than it is in the cutting zone. A solid-lubricant element 15 adjoins the material-removal zone.

The support element 2 has standard cooling channels 16, and in the region of the cooling channels 16 it is provided with furrows 17, which improve chip carry-off.

The support element 2 can also be surface-treated, at least in the peripheral region.

Patent Claims:

1. Cutting tool, for example a saw, especially for the cutting of stone, with a metallic support element and a grind facing made up of cutter segments fixed at intervals on the support element, with a preferably metallic join and an abrasive grain, for example diamond, wherein the grain concentration and/or the grain size and/or the grain type and/or the bonding hardness can differ over the extent of the grind facing, characterized in that the individual cutter segments (1) are heterogeneous in the direction of rotation.

2. Cutting tool based on Claim 1, characterized in that the abrasive-grain quality and/or abrasive-grain concentration in the cutter segments (1) vary over the length of the cutter segment (1).

3. Cutting tool based on Claim 1, characterized in that the abrasive-grain size varies over the length of the cutter segments (1).

4. Cutting tool based on Claim 3, characterized in that the abrasive-grain size is largest in the region of the cutter segments (1) that is leading in the direction of rotation, and decreases over the length of the cutter segments (1).

5. Cutting tool based on Claim 2, characterized in that the abrasive-grain concentration is highest in the region of the cutter segments (1) that is leading in the direction of rotation, and decreases over the length of the cutter segments (1).

6. Cutting tool based on Claim 1, characterized in that the join in the region of the cutter segments (1) that is leading in the direction of rotation is more elastic than the join in the trailing region.

7. Cutting tool based on at least one of the claims 1 to 6, characterized in that several, preferably two, different cutter-segment components, each having a homogeneous structure in itself, are fixed directly one behind the other on the support element (2), with these then comprising one cutter segment (1).

8. Cutting tool based on at least one of the Claims 1 to 7, characterized in that the bonding property changes over the length of a cutter segment (1).

9. Cutting tool based on at least one of the Claims 1 to 8, characterized in that a shock-absorbing layer (12) without any cutting grain is positioned at the cutter-segment (1) ends that are leading in the direction of rotation.

10. Cutting tool based on at least one of the Claims 1 to 9, characterized in that a solid-lubricant element (15) is positioned at the cutter-segment (1) ends that are trailing in the direction of rotation.

11. Cutting tool based on at least one of the Claims 1 to 10, characterized in that in different regions the cutter segments (1) have diamond grain and also have mechanically resistant materials that are other than diamond, e.g. carbides.

Fig. 1

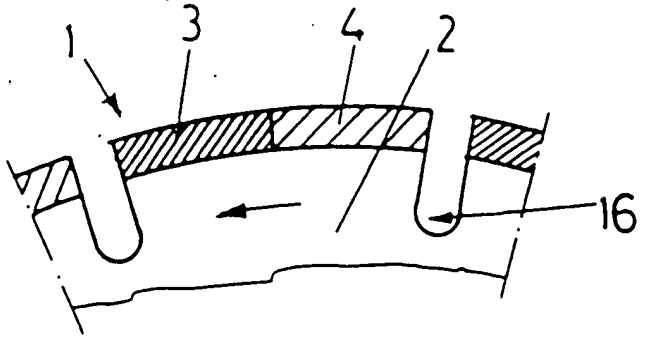


Fig. 2

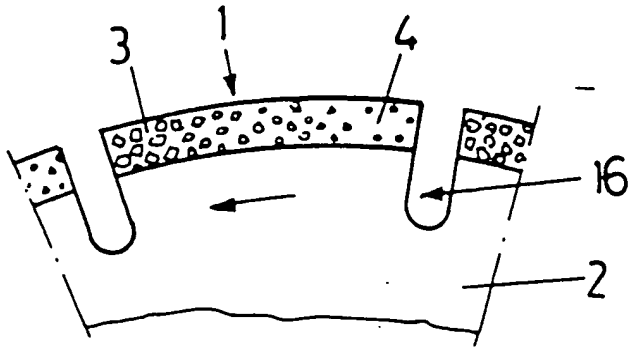


Fig. 3

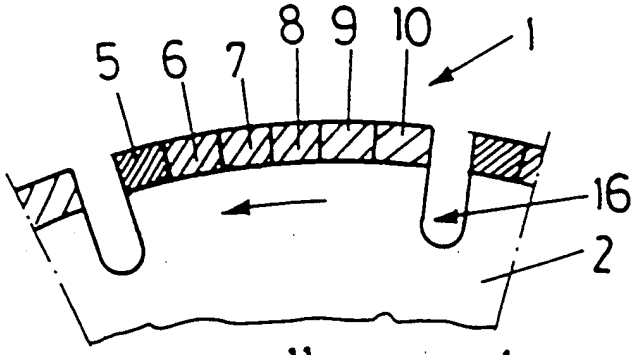


Fig. 4

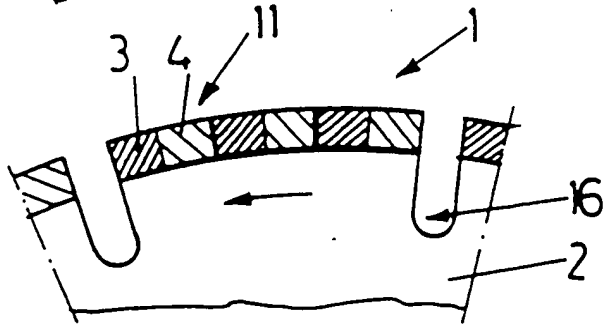
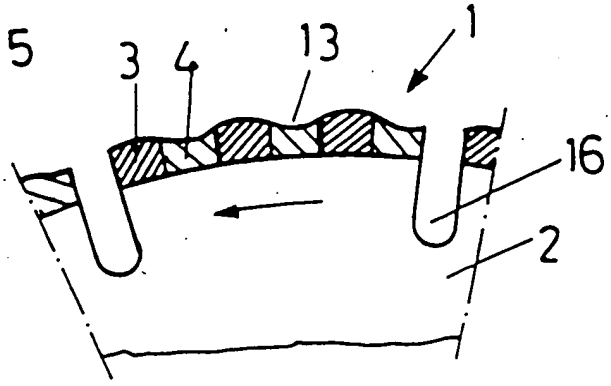


Fig. 5



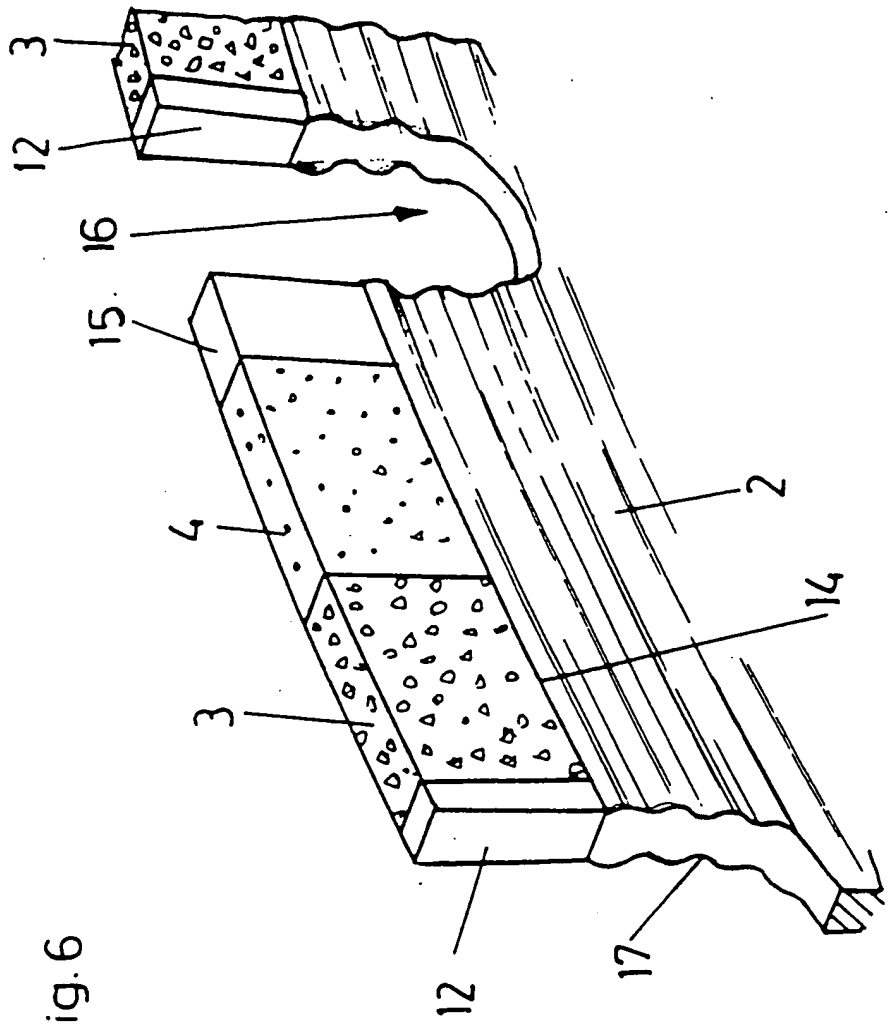


Fig.6

[handwritten:] EP0540566 [logo]

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INTERNATIONAL APPLICATION PUBLISHED PURSUANT TO THE PATENT COOPERATION TREATY (PCT)

(51) **International Patent Classification**[5]: **B28D 1/12, B24D 5/12 B23D 59/02**

A3

(11) **International publication number:** **WO 92/01542**

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A 1559/90 25 July 1990 (25.07.90) AT

(71) **Applicant** *(for all designated states except US):*
TYROLIT SCHLEIFMITTELWERKE SWAROVSKI K.G. [AT/AT]; A-6130 Schwaz (AT).

(72) **Inventor; and**
(75) **Inventor/applicant** *(only for US):*
HAUSBERGER, Peter [AT/AT]; A-6240 Radfeld 150 (AT); KERBER, Benno [AT/AT]; Anton öfner-Strasse 29, A-6130 Schwaz (AT).

(74) **Agent:** TORGGLER, Paul, etc; Wilhelm-Greilstrasse 16, A-6020 Innsbruck (AT).

(81) **Designated nations:** AT (European patent), AU, BE (European patent), CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), JP, LU (European patent), NL (European patent), SE (European patent), US.

Published
With an international search report.
If changes have been made before expiration of the deadline allowed for changes in the claims, publication is to be repeated.

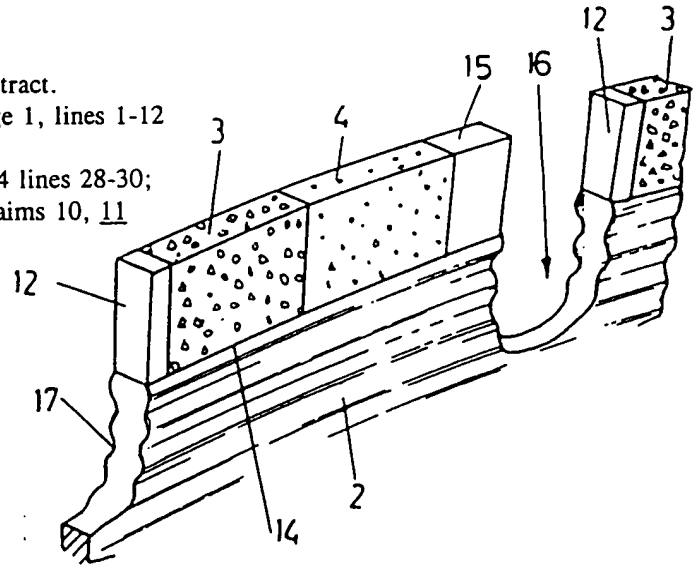
(88) **Publication date of the international search report:**
19 March 1992 (19.03.92)

(54) **Title:** CUTTING TOOL

[handwritten:]
METAL JOIN → Claim 1 + Abstract.
page 1, lines 1-12

Abrasive grain: Abstract → page 4 lines 28-30;
+ Claims 10, 11

Metallic Support - Claim 1



(57) **Abstract** [Original English]:

The invention concerns a cutting tool, e.g. a saw or hollow borer for cutting stone, with a metal support element (2) and, fixed at intervals on the support element, cutter segments (1) with preferably metal join and diamond abrasive grain. The cutter segments (1) are heterogenous in the direction of rotation. For instance, the abrasive-grain quality and/or concentration can vary over the length of the cutter segment (1) and/or the abrasive-grain size can differ. The leading edge of the cutter segment (1) has a shock-absorbing layer (12).

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+ The designati n "SU" is in force in th Russian Federation. It is not yet known whether such designations are in force in other states of the former Soviet Union.

INTERNATIONAL SEARCH REPORT

International Application No. PCT/AT 91/00088

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl.[5] : B28D 1/12, B24D 5/12, B23D 59/02

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
Int. Cl.[5]	B28D, B24D B23Q, B23D

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document [11], with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	Patent Abstracts of Japan, Vol. 6, No. 101 (M-135) [979], 10 June 1982; & JP, A, 57033969 (I. NIROU) 24 February 1982, see the whole abstract	1-3, 7, 9, 11
A		4, 5, 6, 8
X	DE, A, 2438601 (Ernst Winter & Sohn GmbH) 26 February 1976, see page 3, lines 19-25; page 8, lines 7-15; Figure 5	1
A		6, 8
A	DE, A, 1917957 (G. PAHLITZSCH) 29 October 1970, see page 4; Figure 1	4, 5
A	US, A, 1931363 (E. STUBBS) 17 October 1933, see page 2, line 31 - page 3, line 43; Figure	6, 8
A	GB, A, 2053043 (HEINRICH LIPPERT GmbH) 4 February 1981, see page 3, lines 30-35; abstract; Figures 1, 4	6, 8

* Special categories of cited documents: [10]

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particlar relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
24 January 1992 (24.01.92)	13 February 1992 (13.02.92)
International Searching Authority: EUROPEAN PATENT OFFICE	Signature of Authorized Officer

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category*	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	Patent Abstracts of Japan, Vol. 7, No. 29 (M-191) [1174], 5 February 1983; & JP, A, 57184674 (I. NIROU) 13 November 1982, see the whole abstract	9
A	Patent Abstracts of Japan, Vol. 12, No. 296 (M-731) [3143], 12 August 1988; & JP, A, 63074567 (MICRON SEIMITSU K.K.) 5 April 1988, see the whole abstract	11
A	EP, A, 0365843 (GENERAL ELECTRIC CO.) 2 May 1990, see page 3, lines 30-56; Claims 10, 12; Figures 1-7	11
A	Patent Abstracts of Japan, Vol. 10, No. 231 (M-506) [2286], 12 August 1986; JP, A, 61065776 (MATSUSHITA ELECTRIC IND CO LTD) 4 April 1986, see the whole abstract	10
A	FR, A, 1568331 (COMPAGNIE DU DIAMANT INDUSTRIEL) 23 May 1969, see page 2, left hand column, line 39 - page 2, right hand column, line 7; Figures 1-6	10
A	World Patents Index, Section PQ, Woche 7825, Derwent Publications Ltd, (London, GB) Class P61, AN 78-E9180A, & SU, A, 0569440 (YU. L. NEDELIN) 8 September 1977, see abstract	10
A	Soviet Inventions Illustrated, Section PQ, Woche 8623, June 1986, Derwent Publications Ltd (London, GB), Class P54, An 86-148899, & SU, A, 1189652 (A.A. MALYSHEV) 7 November 1985, see abstract	10
A	US, A, 3496973 (R.L. BALLARD) 24 February 1970 see claim 1	10
A	US, A, 2369068 (R.B. Mentzer) 6 February 1945 see page 1, left hand column, lines 33-36; Figures 3, 4	10

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

V. ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [1]

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claim numbers....., because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claim numbers....., because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claim numbers....., because they are dependent claims and are not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☒ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [2]

This International Searching Authority found multiple inventions in this international applications as follows:

1. Claims 1-9, 11

2. Claims 1, 10

For further informations, please see form PCT/ISA/206 dated 9 October 1991 (09.10.91)

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.

2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:

3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:

4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest

☐ No protest accompanied the payment of additional search fees.

ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO. AT 9100088
SA 49491

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on 07/02/92
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
DE-A- 2438601	26-02-76	None		
DE-A- 1917957	29-10-70	None		
US-A- 1931363		None		
GB-A- 2053043	04-02-81	DE-A-	2931695	05-02-81
		AT-B-	376921	25-01-85
		CA-A-	1128320	27-07-82
		CH-A-	646628	14-12-84
		FR-A,B	2459706	16-01-81
		SE-A-	8004172	27-12-80
		US-A-	4338748	13-07-82
		JP-A-	56027782	18-03-81
EP-A- 0365843	02-05-90	US-A-	4883500	28-11-89
		JP-A-	2171215	02-07-90
FR-A- 1568331	23-05-69	None		
US-A- 3496973	24-02-70	None		
US-A- 2369068		None		